NISTTech

Minimizing Spatial-Dispersion-Induced Birefringence

Minimize inherent birefringence of cubic fluoride materials in optical system components

Description

Cubic-shaped fluoride crystals, such as calcium fluoride, strontium fluoride, and barium fluoride, are widely utilized in high precision optics, including UV optical lithography. These crystals exhibit high transmittance within a broad range of wavelengths from the infrared through the UV, below 157 nm. Accordingly, these crystals are used in various kinds of optical elements for precision UV optics, including lenses, prisms, and beam splitters.

Birefringence is a major complication presently associated with crystals used in precision optical systems. Birefringence is primarily caused by mechanical stress or strain incorporated during the crystal fabrication process, and substantial efforts have gone towards reducing this stress-induced birefringence. Cubic crystals have an intrinsic birefringence in addition to stress induced birefringence. The problem of intrinsic birefringence must be addressed in precision UV optical systems because the magnitude of the birefringence in the UV is larger than the present industry specifications. This complication presents serious challenges to optical engineers because, unlike stress-induced birefringence, intrinsic birefringence is inherent to the material, and thus cannot be reduced by material improvements.

Intrinsic birefringence blurs the image, which limits the achievable resolution, and alters the polarization state of light as it traverses the optics, which is significant for optical systems using polarized light. Accordingly, there exists a strong need to correct the problem of intrinsic birefringence in crystals used in high precision UV optical systems.

The present invention provides a composition formed from single-crystal mixed solid solutions of Group II fluorides in which the composition has little or no intrinsic birefringence at a selected wavelength.

Applications

- **Manufacturing high precision UV optical systems**
  For production of quality lenses, beam splitters and prisms.

Advantages

- **High precision optics**
  Minimizes blurriness caused by intrinsic birefringence in compositions of

cubic fluoride crystals.

- **Polarized optics**
  Reduces aberrations due to the alteration of polarization caused by birefringence.

Abstract

A composition formed from Group II fluorides in which the composition has little or no intrinsic birefringence at a selected wavelength. The composition is a mixed solid solution of CaF.sub.2 with a second crystal of SrF.sub.2 or BaF.sub.2. The resulting composition is in the form of Ca.sub.1-xSr.sub.xF.sub.2 or Ca.sub.1-xBa.sub.xF.sub.2, or a combination of SrF.sub.2 and BaF.sub.2, in the form of Ca.sub.1-x-ySr.sub.xBa.sub.yF.sub.2. The specific form of the composition that effectively nulls out the intrinsic birefringence at a selected wavelength within the UV range is determined in one preferred method from the magnitudes of the intrinsic birefringences of the components, CaF.sub.2, SrF.sub.2, and BaF.sub.2.

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References

- U.S. Patent # 7,163,649
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Status of Availability

This is available for non-exclusive licensing.

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